ECF-300FF5-20-0134
Revision 0

CALCULATION OF UPPER CONFIDENCE LIMITS FOR RCRA MONITORING AT THE 300 AREA PROCESS TRENCHES TO SUPPORT THE JUNE - DECEMBER 2020 SEMIANNUAL REPORT

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

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APPROVED
By Sarah Harrison at 9:41 am, Jan 19, 2021

Release Approval | Date

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ENVIRONMENTAL CALCULATION COVER PAGE

SECTION 1 - Completed by the Responsible Manager

Project: Soil and Groundwater Remediation Project

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Calculation Title and Description:
Calculation of Upper Confidence Limits for RCRA Monitoring at the 300 Area Process Trenches to Support the June - December 2020 Semiannual Report

Qualifications Summary

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MS, Geological Sciences, University of Southern California, 2004
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Professional Licenses:

Brief Narrative of Experience: Dr. DiFilippo has extensive experience addressing the fate and transport of organic and inorganic chemicals in the environment. She has conducted numerous studies of groundwater transport, statistical geochemical analysis, groundwater age-dating, dense non-aqueous phase liquid (DNAPL) dissolution, enhanced DNAPL remediation technologies, and the use of innovative technologies for measuring in-situ concentrations of organic contaminants in sediment pore-water. At Hanford, Dr. DiFilippo has provided remediation support in the form of water-level mapping, evaluation of monitored natural attenuation (MNA) and enhanced attenuation (EA), development of methodology to asses the impact of surface water-groundwater interactions on contaminant concentrations and trends, and assessment of statistical methodologies for evaluating RCRA compliance at both interim and final status sites.

Checker(s):

Name: Matthew O'Connell

Degree, Major, Institution, Year: MS, Environmental Sciences, University of Virginia, 2016
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Professional Licenses:

Brief Narrative of Experience: Mr. O'Connell's experience is in organic geochemistry and oceanography, as well as hydrology and geology. He has experience in coordination and analysis of large sets of geochemical data, simulation of hydrologic transport of materials through stream networks, and characterization of biogeochemical relationships through stable isotopes. He has assisted with chemical and isotopic characterization of carbonaceous sediments for the International Ocean Drilling Program and conducted analysis of organic and inorganic nitrogen using Isotope Ratio Mass Spectrometry. He has experience in historical research and map production to determine potential contamination sources.

ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

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PhD, Civil and Environmental Engineering, University of Vermont, 1999

Professional Licenses: Licensed Geologist and Hydrogeologist: Washington, No. 2630 Professional Geologist: Idaho, No. 1248 Registered Geologist: Oregon, No. G2219

Brief Narrative of Experience: Dr. Spiliotopoulos' expertise is analysis to support water resources management. He has developed and applied analytical and numerical models for groundwater flow and contaminant transport, focusing on pump-and-treat system operations, reactive-transport modeling, and optimization applications for least-cost remediation designs. He has extensive experience in assessing water-resources management in support of inter- and intra-state water-resource allocation and conflict resolution, assessment of water quantity and quality data, development and application of statistical tools and numerical interpolation techniques for mapping water-level and water-quality data, and the application of advanced parameter estimation techniques for model calibration. At Hanford, he has designed RPO and RI/FS remedial alternatives, including large-scale pump-and-treat networks and/or MNA and other in-situ treatment technologies for the River Corridor OUs, conducted sitewide multi-constituent plume delineation, and co-authored Remedial Design and Remedial Action Work Plans. He has provided technical support on system performance evaluations and modifications, characterization of plume migration patterns, aquifer test data interpretations as well as practical and theoretical aspects of aquifer hydraulics and their applications. He developed and contributed to numerous presentations to stakeholders, illustrating elements of the proposed remedies, and their impacts on containment and recovery performance.

SECTION 2 - Completed by Preparer

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Preparer(s):

Erica DiFilippo	S Project Geochemist	Erica DiFilippo	12/1/2020
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ENVIRONMENTAL CALCULATION COVER PAGE (Continued)

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Responsible Manager(s):

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William Faught	Manager	Approved Via Attached	01/11/2021

SECTION 5 - Applicable if Calculation is a Risk Assessment or Uses an Environmental Model

Prior to Initiating Modeling:

Required training for modelers completed:
Integration Lead:

Print First and Last Name	Signature	Date
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Integration Lead:

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Calculation Approved:
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Terms

cis-1,2-DCE	1,2-cis-dichloroethylene
ECF	environmental calculation file
HEIS	Hanford Environmental Information System
RCRA	*Resource Conservation and Recovery Act of 1976*
TCE	trichloroethene
UCL	upper confidence limit

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1 Purpose

This environmental calculation file (ECF) presents calculations of 95% upper confidence limits (UCLs) on the mean for *cis*-1,2-dichloroethylene (*cis*-1,2-DCE) and trichloroethene (TCE) at the 300 Area Process Trenches *Resource Conservation and Recovery Act of 1976* (RCRA) site. The 95% UCLs are compared to the applicable concentration limits in the WA7890008967, *Hanford Facility Resource Conservation and Recovery Act (RCRA) Permit, Dangerous Waste Portion for the Treatment, Storage, and Disposal of Dangerous Waste* (hereinafter referred to as the Hanford RCRA Permit). This ECF includes available results for RCRA groundwater samples collected from June 2017 through September 2020.

2 Background

The 300 Area Process Trenches are located within the 300-FF-1 Operable Unit (Figure 1) and were used for disposal of liquid waste from the 300 Area facilities. The final status groundwater monitoring plan was incorporated into the Hanford RCRA Permit, Revision 8c, on May 24, 2017 (Modification 8C.2018.Q1). The groundwater monitoring plan, which is now included in the Hanford RCRA Permit, supersedes WHC-SD-EN-AP-185, *Groundwater Monitoring Plan for the 300 Area Process Trenches*.

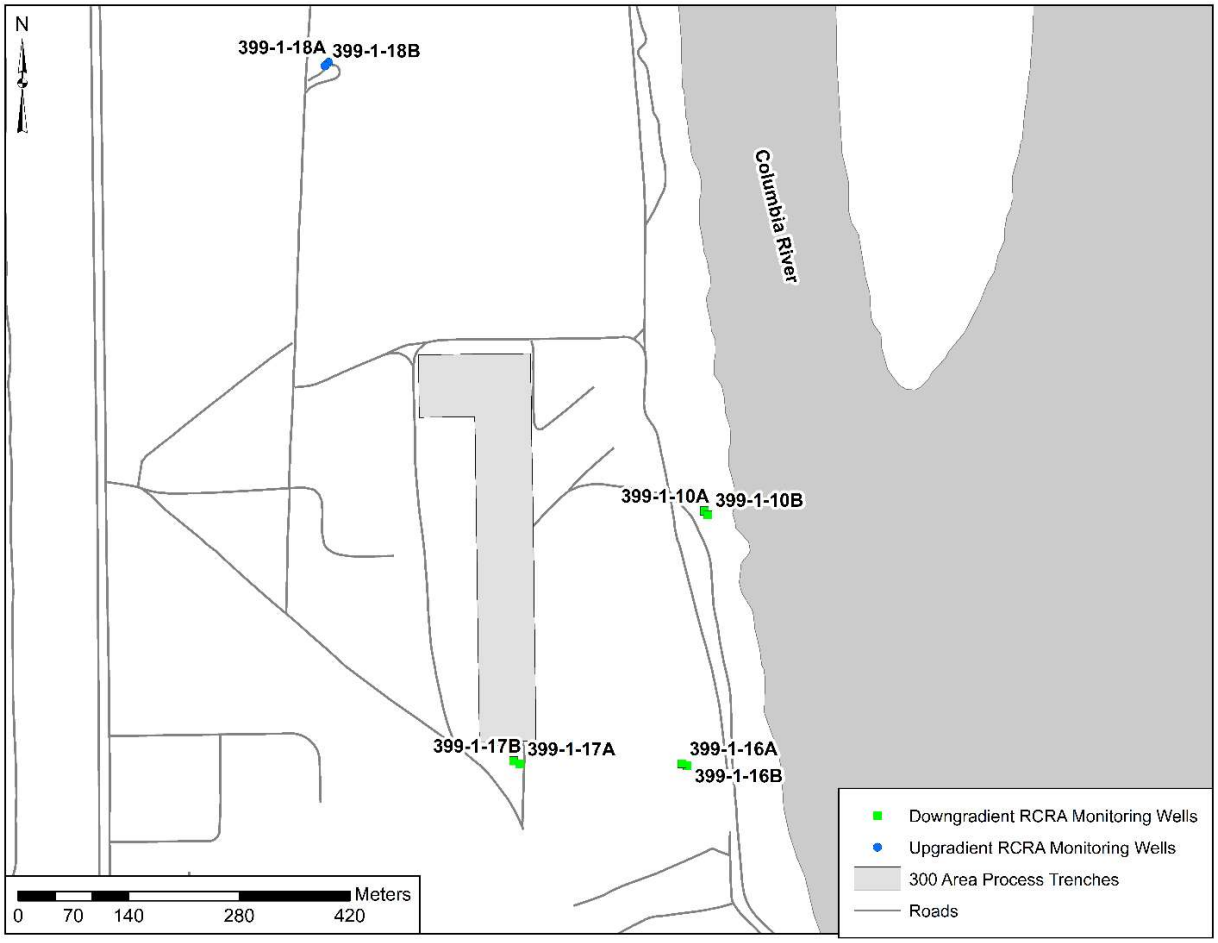

Figure 1. 300 Area Process Trenches and Associated Monitoring Wells

The groundwater monitoring plan requires calculation of 95% UCLs on the mean for *cis*-1,2-DCE and TCE based on the last eight (8) independent samples collected under the previous plan (WHC-SD-EN-AP-185) plus any samples collected under the current groundwater monitoring plan, and comparison of the 95% UCLs to the concentration limits established in the Hanford RCRA Permit. Once 8 semiannual samples have been collected under the current groundwater monitoring plan, sample results collected under the previous plan no longer will be included in data sets. As of September 2020, 8 semiannual samples were collected under the current groundwater monitoring plan between June 2017 and September 2020. Therefore samples collected under the previous plan are no longer included in this data sets. For the 300 Area Process Trenches, the calculation of 95% UCLs only is required for the six downgradient RCRA wells (Figure 1).

When all data in the 95% UCL dataset for a well/analyte pair are less than the concentration limit, calculation of the 95% UCL on the mean is not required and the data are evaluated visually to ensure compliance.

3 Methodology

This section discusses the data and methods used to complete the calculations presented in this document.

3.1 Data Acquisition and Processing Prior to 95% UCL Calculation

This section discusses the acquisition and processing of data prior to the 95% UCL calculation.

3.1.1 Chemistry Data Acquisition

Groundwater chemistry data were downloaded from the Hanford Environmental Information System (HEIS) database, which is maintained by CH2M HILL Plateau Remediation Company, and exported into a Microsoft Access® database (named HEIS_CHEM_11052020.accdb). The data for this analysis were downloaded from the HEIS database on November 5, 2020. One table was downloaded from the HEIS database (HEIS_ADM_PNLGW_STD_RESULT_MV), which contains information on groundwater samples, including laboratory and review data qualifiers, sample medium, sample collection purpose, analytical method, and reporting limits. The fields extracted from the HEIS database for use in calculations described in this document are presented in Table 1.

Table 1. HEIS Database Fields for Chemistry Data

Field Extracted*	Definition
WELL_NAME	Location Identification
SAMP_DATE_TIME	Sampling Date
STD_CON_LONG_NAME	Analyte Name
STD_VALUE_RPTD	Reported Concentration
STD_ANAL_UNITS_RPTD	Units for Concentration Measurement
LAB_QUALIFIER	Laboratory Data Qualifier

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Table 1. HEIS Database Fields for Chemistry Data

Field Extracted*	Definition
REVIEW_QUALIFIER	Review Data Qualifier
COLLECTION_PURPOSE	Primary Reason for Sample Collection
VALIDATION_QUALIFIER	Validation Qualifier
MEDIA	Sample Medium
METHOD_NAME	Analytical Method
REPORTING_LIMIT	Reporting Limit

*Field codes are defined in HNF-38155, *HEIS Sample, Result, and Sampling Site Data Dictionary*.

3.1.2 Data Qualifiers

Nondetects in the chemistry data sets were identified using the laboratory qualifier (LAB_QUALIFIER = U or combination of any qualifier and U). All estimated data (LAB_QUALIFIER = B or J) were treated as detected values. Rejected ("R"-flagged) data in the HEIS database were not included for statistical evaluation. The chemistry data sets contained no rejected data.

3.1.3 Wells and Constituents

The list of wells and constituents for this analysis was based on the groundwater monitoring plan incorporated on May 24, 2017, into the Hanford RCRA Permit (WA7890008967), Modification 8C.2018.Q1, as listed in Table 2.

Table 2. Wells and Constituents

Well Name	Constituent
399-1-10A	*cis*-1,2-dichloroethylene, trichloroethene
399-1-10B	*cis*-1,2-dichloroethylene, trichloroethene
399-1-16A	*cis*-1,2-dichloroethylene, trichloroethene
399-1-16B	*cis*-1,2-dichloroethylene, trichloroethene
399-1-17A	*cis*-1,2-dichloroethylene, trichloroethene
399-1-17B	*cis*-1,2-dichloroethylene, trichloroethene

As of September 2020, 8 semiannual samples have been collected under the current groundwater monitoring plan, therefore, no data from the previous plan are used in this analysis.

3.1.4 Daily Averaging

A daily average was calculated for chemistry data with multiple measurements on the same day. When all measurements on the same day were nondetect, the highest detection limit was used for the daily value. For daily duplicates where only one of the samples was nondetect, the detected value was used for the daily value. Duplicate daily measurements and the calculated daily average are presented in Table 3.

Table 3. Duplicate Daily Measurements and Calculated Daily Averages

Well Name	Constituent	Sample Date	Measured Concentration	Calculated Daily Average
399-1-17A	*cis*-1,2-DCE	10/24/2017	0.3U µg/L 0.3U µg/L	0.3U µg/L
399-1-17A	*cis*-1,2-DCE	9/4/2018	0.3U µg/L 0.3U µg/L	0.3U µg/L
399-1-17A	*cis*-1,2-DCE	9/3/2020	0.333U µg/L 0.333U µg/L	0.333U µg/L
399-1-10A	TCE	6/18/2020	0.33U µg/L 0.33U µg/L	0.33U µg/L
399-1-17A	TCE	10/24/2017	0.3U µg/L 0.3U µg/L	0.3U µg/L
399-1-17A	TCE	9/4/2018	0.3U µg/L 0.3U µg/L	0.3U µg/L
399-1-17A	TCE	9/3/2020	0.333U µg/L 0.333U µg/L	0.333U µg/L

TCE = trichloroethene

U = Constituent not detected above the method detection limit shown.

3.1.5 Time Period of Analysis

Datasets were selected in accordance with the groundwater monitoring plan incorporated into the Hanford RCRA Permit and includes the data from the last 8 RCRA sampling events (June 2017 to September 2020) (Table 4).

Table 4. Sampling Data

Well Name	Analyte	Sampling Date Range	Number of Samples
399-1-10A	*cis*-1,2-DCE	6/2/2017 – 9/3/2020	8
399-1-10B	*cis*-1,2-DCE	6/2/2017 – 9/3/2020	8
399-1-16A	*cis*-1,2-DCE	6/2/2017 – 9/3/2020	8
399-1-16B	*cis*-1,2-DCE	6/2/2017 – 9/3/2020	8
399-1-17A	*cis*-1,2-DCE	6/2/2017 – 9/3/2020	8
399-1-17B	*cis*-1,2-DCE	6/2/2017 – 9/3/2020	8
399-1-10A	TCE	6/2/2017 – 9/3/2020	8
399-1-10B	TCE	6/2/2017 – 9/3/2020	8
399-1-16A	TCE	6/2/2017 – 9/3/2020	8
399-1-16B	TCE	6/2/2017 – 9/3/2020	8
399-1-17A	TCE	6/2/2017 – 9/3/2020	8
399-1-17B	TCE	6/2/2017 – 9/3/2020	8

cis-1,2-DCE = *cis*-1,2-dichloroethylene
TCE = trichloroethene

3.1.6 Outliers

The data sets were evaluated for outliers through visual inspection of timeseries plots. No outliers were identified in the datasets used in this analysis.

3.2 Calculated 95% UCLs on the Mean

A statistical software package, ProUCL version 5.1, was used to calculate the 95% UCL on the mean, in accordance with the groundwater monitoring plan. ProUCL is available through the U.S. Environmental Protection Agency and provides statistical methods and graphical tools that are commonly used in environmental assessments. ProUCL is capable of working with datasets where nondetects, samples with concentrations less than the reporting limit, are present. There are several methods available in ProUCL for calculating 95% UCLs on the mean. These methods account for the underlying distribution of the data and the presence of nondetects. For datasets with nondetects, ProUCL uses the Kaplan-Meier method, a nonparametric method for calculating the mean and standard deviation. ProUCL highlights a recommended method in its output file; however, it is important to assess all the methods available and independently verify the most appropriate method through visual inspection of the data, evaluation of the number of available data points, and the data distribution.

The 95% UCL calculations were performed on datasets with at least one sample above the concentration limit. As shown in Table 5, only one dataset met this criterion. Calculation of 95% UCLs for the other datasets was not required.

Table 5. Dataset Summary and Criteria to Calculate 95% UCL

Analyte	Concentration Limit	Well Name	Number of Samples	Percent Nondetect	Number of Samples Exceeding Concentration Limit	95% UCL Calculation Required
cis-1,2-DCE	16 µg/L	399-1-10A	8	100%	0	No
		399-1-10B	8	100%	0	No
		399-1-16A	8	100%	0	No
		399-1-16B	8	0%	8	**Yes**
		399-1-17A	8	100%	0	No
		399-1-17B	8	13%	0	No
TCE	4 µg/L	399-1-10A	8	100%	0	No
		399-1-10B	8	100%	0	No
		399-1-16A	8	88%	0	No
		399-1-16B	8	0%	0	No
		399-1-17A	8	88%	0	No
		399-1-17B	8	100%	0	No

cis-1,2-DCE = *cis*-1,2-dichloroethylene
TCE = trichloroethene
UCL = upper confidence limit

4 Assumptions

The following is a summary of assumptions made in this analysis:

- Concentrations observed at a well are not significantly affected by active remediation activities at the site for the period over which calculations are made.
- There are no concentration trends with time for the datasets used to calculate 95% UCLs. ProUCL does not explicitly test for concentration trends when calculating 95% UCLs. In the presence of a concentration trend, ProUCL will calculate a wider confidence interval on the mean, and thus a higher 95% UCL.
- All of the data for a well/analyte pair are from the same statistical distribution.

5 Software Applications

95% UCL calculations were performed using ProUCL version 5.1.

6 Calculation

The following input files were used in the implementation of this analysis:

- *qryChemHeis1.txt* and *qryChemHeis2.txt*: Concentration data from the HEIS database
- *ProUCL_Datasets_11052020.xlsx*: datasets for use in ProUCL

Datasets were imported into the ProUCL software, and 95% UCLs were calculated using all available methods with accounting for the presence of nondetects. The reported 95% UCL was selected based on the ProUCL results, including evaluation of the data distribution and sample size.

7 Results

The dataset evaluated for 95% UCL calculation and the output file from ProUCL are presented in Appendix A, and the 95% UCL result is presented in Table 6.

Timeseries plots for all wells and constituents are presented in Appendix B. Of the downgradient wells, only 399-1-16B currently exceeds the concentration limit for *cis*-1,2-DCE. None of the downgradient wells exceeds the concentration limit for TCE.

Table 6. Calculated 95% UCLs

Well Name	Analyte	Concentration Limit	95% UCL	95% UCL Result Evaluation
399-1-16B	*cis*-1,2-DCE	16 µg/L	156* µg/L	Above Concentration Limit

*ProUCL method: 95% Student's-t UCL

cis-1,2-DCE = *cis*-1,2-dichloroethylene

UCL = upper confidence limit

8 References

HNF-38155, 2011, *HEIS Sample, Result, and Sampling Site Data Dictionary*, Rev. 1, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/0082589H.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

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WHC-SD-EN-AP-185, 1995, *Groundwater Monitoring Plan for the 300 Area Process Trenches*, Rev.0, Westinghouse Hanford Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196020117.

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Appendix A

Upper Confidence Limit (UCL) Datasets and ProUCL Output Results

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Table A-1. Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Nondetect Identification*
399-1-10A	6/2/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	10/24/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	6/6/2018	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10A	9/5/2018	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10A	6/17/2019	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	9/19/2019	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10A	6/18/2020	cis-1,2-Dichloroethylene	0.333	ug/L	U	0
399-1-10A	9/3/2020	cis-1,2-Dichloroethylene	0.333	ug/L	U	0
399-1-10B	6/2/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	10/22/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	6/6/2018	cis-1,2-Dichloroethylene	0.15	ug/L	U	0
399-1-10B	9/5/2018	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-10B	6/17/2019	cis-1,2-Dichloroethylene	0.23	ug/L	U	0
399-1-10B	9/19/2019	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-10B	6/18/2020	cis-1,2-Dichloroethylene	0.39	ug/L	U	0
399-1-10B	9/3/2020	cis-1,2-Dichloroethylene	0.39	ug/L	U	0
399-1-16A	6/2/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	10/24/2017	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	6/6/2018	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	9/6/2018	cis-1,2-Dichloroethylene	0.1	ug/L	U	0
399-1-16A	6/18/2019	cis-1,2-Dichloroethylene	0.23	ug/L	U	0
399-1-16A	9/20/2019	cis-1,2-Dichloroethylene	0.23	ug/L	U	0
399-1-16A	6/22/2020	cis-1,2-Dichloroethylene	0.23	ug/L	U	0
399-1-16A	9/3/2020	cis-1,2-Dichloroethylene	0.333	ug/L	U	0
399-1-16B	6/2/2017	cis-1,2-Dichloroethylene	136	ug/L	D	1
399-1-16B	10/24/2017	cis-1,2-Dichloroethylene	160	ug/L	D	1
399-1-16B	6/6/2018	cis-1,2-Dichloroethylene	130	ug/L	D	1
399-1-16B	9/6/2018	cis-1,2-Dichloroethylene	140	ug/L	D	1
399-1-16B	6/18/2019	cis-1,2-Dichloroethylene	169	ug/L	DX	1
399-1-16B	9/20/2019	cis-1,2-Dichloroethylene	147	ug/L	D	1
399-1-16B	6/22/2020	cis-1,2-Dichloroethylene	150	ug/L	D	1
399-1-16B	9/3/2020	cis-1,2-Dichloroethylene	148	ug/L	D	1
399-1-17A	6/2/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	10/24/2017	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	6/6/2018	cis-1,2-Dichloroethylene	0.3	ug/L	U	0

Table A-1. Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Nondetect Identification*
399-1-17A	9/4/2018	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	6/18/2019	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	9/20/2019	cis-1,2-Dichloroethylene	0.3	ug/L	U	0
399-1-17A	6/18/2020	cis-1,2-Dichloroethylene	0.333	ug/L	U	0
399-1-17A	9/3/2020	cis-1,2-Dichloroethylene	0.333	ug/L	U	0
399-1-17B	6/2/2017	cis-1,2-Dichloroethylene	1.9	ug/L		1
399-1-17B	10/24/2017	cis-1,2-Dichloroethylene	1.2	ug/L		1
399-1-17B	6/6/2018	cis-1,2-Dichloroethylene	1	ug/L		1
399-1-17B	9/6/2018	cis-1,2-Dichloroethylene	0.82	ug/L	J	1
399-1-17B	6/17/2019	cis-1,2-Dichloroethylene	0.23	ug/L	U	0
399-1-17B	9/20/2019	cis-1,2-Dichloroethylene	0.69	ug/L	J	1
399-1-17B	6/18/2020	cis-1,2-Dichloroethylene	0.89	ug/L	J	1
399-1-17B	9/3/2020	cis-1,2-Dichloroethylene	0.7	ug/L	J	1
399-1-10A	6/2/2017	Trichloroethene	0.3	ug/L	U	0
399-1-10A	10/24/2017	Trichloroethene	0.3	ug/L	U	0
399-1-10A	6/6/2018	Trichloroethene	0.25	ug/L	U	0
399-1-10A	9/5/2018	Trichloroethene	0.25	ug/L	U	0
399-1-10A	6/17/2019	Trichloroethene	0.3	ug/L	U	0
399-1-10A	9/19/2019	Trichloroethene	0.3	ug/L	U	0
399-1-10A	6/18/2020	Trichloroethene	0.333	ug/L	U	0
399-1-10A	9/3/2020	Trichloroethene	0.333	ug/L	U	0
399-1-10B	6/2/2017	Trichloroethene	0.25	ug/L	U	0
399-1-10B	10/22/2017	Trichloroethene	0.25	ug/L	U	0
399-1-10B	6/6/2018	Trichloroethene	0.16	ug/L	U	0
399-1-10B	9/5/2018	Trichloroethene	0.25	ug/L	U	0
399-1-10B	6/17/2019	Trichloroethene	0.31	ug/L	U	0
399-1-10B	9/19/2019	Trichloroethene	0.5	ug/L	U	0
399-1-10B	6/18/2020	Trichloroethene	0.5	ug/L	U	0
399-1-10B	9/3/2020	Trichloroethene	0.5	ug/L	U	0
399-1-16A	6/2/2017	Trichloroethene	0.25	ug/L	U	0
399-1-16A	10/24/2017	Trichloroethene	0.25	ug/L	U	0
399-1-16A	6/6/2018	Trichloroethene	0.35	ug/L	J	1
399-1-16A	9/6/2018	Trichloroethene	0.25	ug/L	U	0
399-1-16A	6/18/2019	Trichloroethene	0.31	ug/L	U	0
399-1-16A	9/20/2019	Trichloroethene	0.31	ug/L	U	0

Table A-1. Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Nondetect Identification*
399-1-16A	6/22/2020	Trichloroethene	0.31	ug/L	U	0
399-1-16A	9/3/2020	Trichloroethene	0.333	ug/L	U	0
399-1-16B	6/2/2017	Trichloroethene	1.73	ug/L	J	1
399-1-16B	10/24/2017	Trichloroethene	1.2	ug/L		1
399-1-16B	6/6/2018	Trichloroethene	1.5	ug/L		1
399-1-16B	9/6/2018	Trichloroethene	1.3	ug/L		1
399-1-16B	6/18/2019	Trichloroethene	1.57	ug/L	J	1
399-1-16B	9/20/2019	Trichloroethene	1.41	ug/L	J	1
399-1-16B	6/22/2020	Trichloroethene	1.7	ug/L		1
399-1-16B	9/3/2020	Trichloroethene	1.6	ug/L	J	1
399-1-17A	6/2/2017	Trichloroethene	0.32	ug/L	J	1
399-1-17A	10/24/2017	Trichloroethene	0.3	ug/L	U	0
399-1-17A	6/6/2018	Trichloroethene	0.3	ug/L	U	0
399-1-17A	9/4/2018	Trichloroethene	0.3	ug/L	U	0
399-1-17A	6/18/2019	Trichloroethene	0.5	ug/L	U	0
399-1-17A	9/20/2019	Trichloroethene	0.3	ug/L	U	0
399-1-17A	6/18/2020	Trichloroethene	0.333	ug/L	U	0
399-1-17A	9/3/2020	Trichloroethene	0.333	ug/L	U	0
399-1-17B	6/2/2017	Trichloroethene	0.25	ug/L	U	0
399-1-17B	10/24/2017	Trichloroethene	0.25	ug/L	U	0
399-1-17B	6/6/2018	Trichloroethene	0.16	ug/L	U	0
399-1-17B	9/6/2018	Trichloroethene	0.25	ug/L	U	0
399-1-17B	6/17/2019	Trichloroethene	0.31	ug/L	U	0
399-1-17B	9/20/2019	Trichloroethene	0.5	ug/L	U	0
399-1-17B	6/18/2020	Trichloroethene	0.5	ug/L	U	0
399-1-17B	9/3/2020	Trichloroethene	0.5	ug/L	U	0

*Value used in ProUCL to identify nondetects (0) and detected values (1).

Qualifier Definitions:

D = Analyte was reported at a secondary DF, typically DF > 1.

J = Estimated value; constituent detected at a level less than the RDL or PQL and greater than or equal to the MDL.

X = ALL - The result-specific translation of this qualifier code is provided in the hardcopy data report and/or case narrative. Additional result-specific translation information may also be found in the RESULT COMMENT field for this record.

U = Analyzed for but not detected above limiting criteria.

DF = dilution factor

MDL = method detection limit

Table A-1. Dataset for 300 Area Process Trenches

Well Name	Sample Date	Analyte	Reported Value	Units	Qualifier	ProUCL Nondetect Identification*

PQL = practical quantitation limit
RDL = report detection limit
UCL = upper confidence limit

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.111/23/2020 4:10:51 PM
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

399-1-16B

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
		Number of Missing Observations	0
Minimum	130	Mean	147.5
Maximum	169	Median	147.5
SD	12.65	Std. Error of Mean	4.472
Coefficient of Variation	0.0858	Skewness	0.433

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.172	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	156	95% Adjusted-CLT UCL (Chen-1995)	155.6
		95% Modified-t UCL (Johnson-1978)	156.1

Gamma GOF Test

A-D Test Statistic	0.188	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.156	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	157.4	k star (bias corrected MLE)	98.45
Theta hat (MLE)	0.937	Theta star (bias corrected MLE)	1.498
nu hat (MLE)	2518	nu star (bias corrected)	1575
MLE Mean (bias corrected)	147.5	MLE Sd (bias corrected)	14.87
		Approximate Chi Square Value (0.05)	1484
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	1462

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	156.6	95% Adjusted Gamma UCL (use when n<50)	159

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.979	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.157	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.868	Mean of logged Data	4.991
Maximum of Logged Data	5.13	SD of logged Data	0.085

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	160.8
95% Chebyshev (MVUE) UCL	166.8	97.5% Chebyshev (MVUE) UCL	175.2
99% Chebyshev (MVUE) UCL	191.6		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	154.9	95% Jackknife UCL	156
95% Standard Bootstrap UCL	154.4	95% Bootstrap-t UCL	158.1
95% Hall's Bootstrap UCL	159.2	95% Percentile Bootstrap UCL	154.8
95% BCA Bootstrap UCL	154.8		
90% Chebyshev(Mean, Sd) UCL	160.9	95% Chebyshev(Mean, Sd) UCL	167
97.5% Chebyshev(Mean, Sd) UCL	175.4	99% Chebyshev(Mean, Sd) UCL	192

Suggested UCL to Use

95% Student's-t UCL	156

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

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Appendix B

Timeseries Plots

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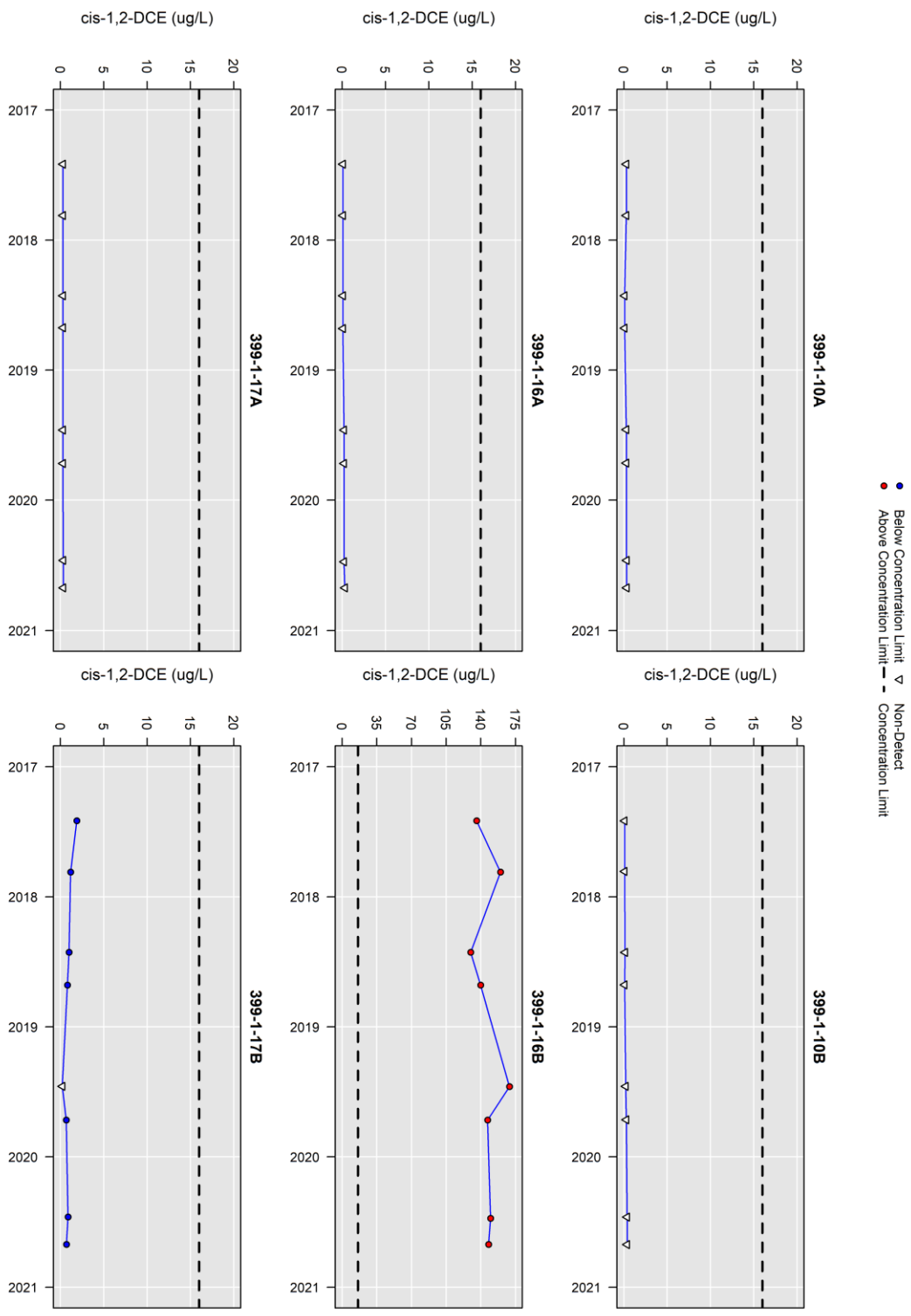

Figure B-1. cis-1,2-Dichloroethylene

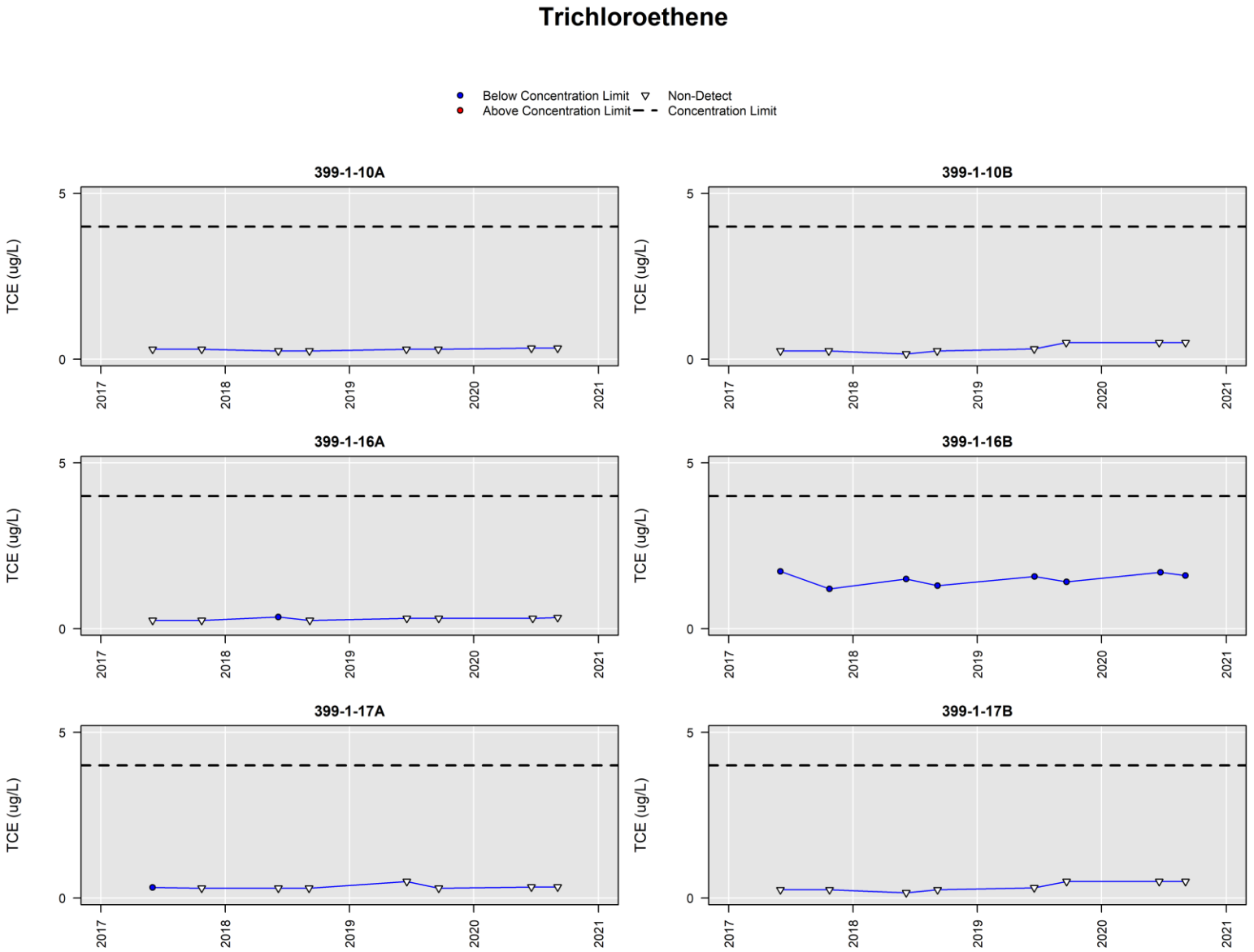

Figure B-2. Trichloroethene